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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

In the Matter of	)	
	)	
Amendment of Parts 2 and 25 of the	)	ET Docket No. 98-206
Commission's Rules to Permit Operation of	)	RM-9147
NGSO and FSS Systems Co-Frequency	)	RM-9245
With GSO and Terrestrial Systems in the	)	
Ku-Band Frequency Range	)	
	)	
and	)	
	)	
Amendment of the Commission's Rules to	)	
Authorize Subsidiary Terrestrial Use of the	)	
12.2-12.7 GHz Band by Direct Broadcast	)	
Satellite Licensees and Their Affiliates	)	

COMMENTS OF TELESAT CANADA

1. Telesat Canada ("Telesat") hereby submits the following comments in response to the Notice of Proposed Rulemaking ("NPRM") released by the Federal Communications Commission ("FCC" or the "Commission") on 24 November 1998 in the above captioned proceeding.

2. In this NPRM, the FCC is proposing to permit non-geostationary satellite orbit ("NGSO") fixed-satellite service ("FSS") operations in certain segments of the Ku-band and proposes rules and policies to govern such operations. The Commission also seeks comment on technical criteria to ensure that such NGSO FSS operations do not cause unacceptable interference to existing users or unduly constrain future growth of incumbent services. More specifically, interested parties are asked to examine the spectrum sharing criteria developed at the 1997 International Telecommunication Union ("ITU") World Radiocommunication Conference ("WRC-97") to permit NGSO FSS operations in various segments of the Ku-band, and comment on whether these proposals are adequate to protect existing services in the Ku-band from unacceptable interference from NGSO FSS operations. This proceeding also responds to

petitions filed by SkyBridge LLC ("SkyBridge") and by Northpoint Technology ("Northpoint") on related matters.

3. As indicated at paragraphs 9 and 10 of the NPRM, there is already extensive use in the United States by incumbent geostationary-satellite orbit ("GSO") and terrestrial service operations providing important and valuable services to the public on the frequency bands proposed for NGSO operations. Accordingly, while the Commission wants to promote competition and innovation by allowing new services or additional spectrum use, it confirms that there is a need to consider the competing interests of the incumbent services in these bands. The incumbent services listed by the Commission include domestic Broadcast Satellite Service ("BSS"), FSS, Government operations and terrestrial fixed and mobile service operations.

4. Given the close proximity of Canada and the United States, just as there is a concern that the proposed NGSO operations licenced in the United States in the Ku-band may cause technical interference with the incumbent services in the United States, the same concern holds true that such operations may cause interference with similar services in Canada. As a provider of FSS and BSS facilities in the Ku-band in Canada, Telesat therefore has a direct interest in the outcome of this proceeding and is concerned that these NGSO operations will cause interference with its existing and future services. Telesat also currently provides some limited service in the United States and is planning to expand on those operations pursuant to the opportunities made possible under the WTO Agreement on trade in basic telecom services. These operations may also be adversely impacted by NGSO operations in the absence of appropriate safeguards to protect against harmful interference. Indeed with the wide-scale liberalization of satellite markets under the WTO Agreement, there is an increased need to ensure harmonization among all regional and international operators to protect against harmful interference.

5. In what follows, Telesat will first provide its comments on the need for further technical studies and on power flux density ("pfd") limit issues. General comments on certain other issues being considered in this proceeding are then presented.

THE NEED FOR FURTHER TECHNICAL INFORMATION

6. Telesat's primary concern is that much of the technical information and analysis necessary to make an informed decision on the matters being considered in this proceeding is not yet available. Until these matters have been resolved in the ITU process, Telesat respectfully submits that it would be premature for the Commission to make a final ruling.

7. For example, as stated at paragraph 2 of the NPRM, SkyBridge indicated in its petition that NGSO FSS systems should be permitted to operate in the Ku-band subject to two conditions – 1) the system will cause no noticeable degradation to the quality or availability of GSO satellite operations and terrestrial links; and 2) the system will impose no operational constraints on GSO satellite and terrestrial operators – and has proposed technical criteria which it claims would protect GSO satellite and terrestrial operations in these bands from interference from NGSO FSS systems. Telesat concurs with the two conditions SkyBridge proposes on the operation of NGSO FSS systems in these bands. However, regarding the technical criteria proposed by SkyBridge to protect GSO satellite operations from harmful interference, Telesat notes that Joint Task Group 4-9-11 (the "JTG"), which was established at WRC-97 to study the issue of co-frequency sharing between NGSO and GSO FSS systems, has not yet concluded its deliberations on these matters.

8. In fact, at its most recent meeting of January 20 to 29, 1999, the JTG decided to refer uncompleted technical discussions to Joint Working Party 10-11S and Working Party 4A of the ITU-R for completion at their respective meetings in May of this year. Without conclusion of the technical deliberations, it is difficult to determine if SkyBridge's proposed technical criteria are sufficient to meet the two criteria it suggests. Indeed, until this analysis is completed and the results are reviewed at WRC-2000, it may be premature to reach any definitive conclusions on any of these matters. The Commission would appear to be in agreement with this, as it indicated at paragraph 7 of the NPRM that it will consider the outcome of this international work, and particularly WRC-2000, for domestic NGSO FSS operations. In light of all this, Telesat is of the view that the Commission should postpone any consideration of these technical issues until after WRC-2000, by which time all the pertinent technical information should be available on which to make a fully informed decision.

9. In this regard, Telesat notes, as confirmed at paragraphs 4 and 5 of the NPRM, WRC-97 adopted only "provisional" equivalent power flux density ("epfd") and aggregate power flux density ("apfd") limits for certain segments of the Ku- and Ka-bands to protect incumbent GSO FSS and BSS operations, pending the completion of technical studies by the relevant ITU Radiocommunication Sector study groups and their review at WRC-2000.

10. It should be further noted that the proposed definition of apfd is likely to change to $epfd_{up}$. (Ref. ITU-R JTG 4-9-11 doc. TEMP/40 Rev. 2) Thus, the provisional limits of apfd used to establish uplink interference limits at WRC-97 are no longer valid. The impact of this change in definition has not yet been fully studied by the JTG or the relevant study groups.

11. Moreover, the provisional limits of epfd adopted at WRC-97 were "single entry" limits, and some ITU administrations (e.g., France) have since proposed aggregate limits at the JTG whose cumulative distribution functions, for the most part, exceed the WRC-97 provisional limits. (Ref. ITU-R JTG 4-9-11 doc. TEMP/92 Rev. 1) Canada and other ITU administrations have demonstrated difficulty with the single entry provisional limits and thus would have difficulty with higher aggregate limits as it is the aggregate impact on existing GSO FSS systems which determines whether or not those systems are interfered with beyond an acceptable limit.

12. Telesat would also note that, although the JTG has met three times since WRC-97, the areas of most significant progress have centered on agreement of methodologies and criteria for assessing the impact of NGSO FSS systems on other systems. Although a large number of GSO FSS links have been studied within the JTG, these were evaluated only against the single entry provisional limits adopted at WRC-97. Moreover, at the January 1999 meeting of the JTG, with regard to the links submitted in response to the ITU's Circular Letter CR92 (issued for the purpose of gathering GSO FSS parameters), problems were identified in the initial spreadsheet in CR-92. Some links submitted may not necessarily represent the worst case in terms of their susceptibility to NGSO interference. (Ref. JTG 4-9-11/INFO/1, 20 Jan 1999) Furthermore, as of the last meeting of the JTG, no conclusion has yet been reached as to how to allocate excess margin (i.e., more margin available than necessary to achieve the target link availability) to interfering NGSO FSS systems. (Ref. ITU-R JTG 4-9-11 doc. TEMP/55)

13. At paragraph 17 of the NPRM, the FCC requests a thorough analysis testing the adequacy of the provisional apfd/epfd limits adopted at WRC-97. Telesat has conducted some of this analysis using Canadian satellites. Representative GSO/FSS links for these satellites for which the WRC-97 provisional epfd limits for NGSO FSS causes unacceptable levels of interference are presented in Annex A.

14. At paragraph 37 of the NPRM, comment is sought on whether the apfd definition should take into account the GSO satellite receive antenna directivity. Telesat notes that at the January 1999 meeting of the JTG, this definition was modified to include the GSO satellite receive antenna directivity. This revised definition would be acceptable provided that the resulting interference into GSO FSS uplinks is less than or the same as the interference with the previous definition. However, the limit of -170 dB(W/m^2/4kHz) was only provisionally accepted at the JTG meeting pending further studies on the impact of the change in definition.

15. At paragraph 41 of the NPRM, the Commission notes that a NASA study found that the SkyBridge system was not operating in accordance with S5.502 of the Radio Regulations. If both the NGSO and GSO FSS are to operate on a level playing field, the same regulatory provisions governing equivalent isotropically radiated power ("eirp") limits and transmitting antenna size must apply to both services.

16. At paragraph 60 of the NPRM, the FCC seeks comment on what percentage of time (e.g., 90%) that a "not-to-be-exceeded" epfd value would be appropriate. Studies within the JTG have shown that taking into account simultaneous interference from NGSO systems (in the form of provisional or other proposed epfd limits) and slant path fading of the GSO FSS system, lower epfd levels associated with percentages of time less than about 99% at Ku-band, or about 90% at Ka-band, have little effect on lowering the overall degradation to availability on the GSO FSS link.

17. At paragraph 80 of the NPRM, it is noted that the JTG is developing a software specification for use by the ITU in determining if a NGSO FSS system meets the pfd, epfd and apfd limits to protect other services, and that within the United States there is a need to verify that a proposed system meets the appropriate limits. In addition to having a software tool to

ensure that a NGSO FSS licensee will meet applicable limits, Telesat submits that a supplementary procedure such as that being developed within ITU-R Working Party 4A, should also be used for validating the actual hardware performance of an NGSO FSS satellite while in-orbit. (Ref. ITU-R JTG 4-9-11 doc. TEMP/92 (Rev.1)

18. As the foregoing demonstrates, much technical analysis still needs to be done to establish appropriate means and limits to protect other services from NGSO systems. Without this information, there is a strong possibility that inappropriate limits may be established, providing less than adequate protection against harmful interference to these other services. Telesat respectfully submits that this work should be completed before the FCC renders any decisions on these matters in this proceeding.

COMMENT ON OTHER ISSUES

19. While Telesat's main concerns in this proceeding pertain to pdf limit issues, Telesat would like to offer the following comments on certain other issues set out in the NPRM.

20. At paragraphs 23 and 24 of the NPRM, the Commission has proposed that it will create exclusion zones of 100 kilometers in radius around the 50 largest urban centers in the United States in which NGSO FSS Gateway earth stations operating in the 10.7 – 11.7 GHz band could not be located. These exclusion zones would be created to mitigate levels of harmful interference into the fixed satellite service and terrestrial systems and earth stations in the 10.7 – 11.7 GHz band. At least three of the 50 largest U.S. urban centers – Detroit, Seattle and Buffalo – are located within 100 kilometers of the border with Canada. Should SkyBridge Gateways be established near any of these urban centers, the establishment of such exclusion zones in the United States may result in the eventual location of NGSO Gateway earth stations closer to the border and near Canadian cities, thereby making it impossible to achieve a similar low interference objective in portions of Canada. To protect against this possibility, and the reciprocal concern of locating NGSO Gateway earth stations in Canada close to large U.S. urban centers, there would appear to be a need for the U.S. and Canadian governments to harmonize their respective positions on these matters.

21. At paragraph 17 of the NPRM, it is proposed to modify footnote NG104 to permit domestic NGSO FSS systems to operate in the 10.7-11.7 GHz band while retaining the "international systems only" requirement for GSO FSS systems in the same band. In Telesat's view, such a modification would grant undue preference to NGSO systems relative to GSO systems that may be offering competitive services. Either the limitation should be maintained for all systems, or removed for all systems.

22. At paragraph 27 of the NPRM, regarding protection of GSO FSS earth stations employing antennas larger than 10 meters at Ku-band and protection of GSO FSS earth stations receiving signals from satellites in inclined orbit, Telesat agrees that antennas of diameter greater than 10 meters should be coordinated on a case-by-base basis. Any incidence of synchronization loss to an existing GSO FSS link under clear-sky operating conditions solely due to the introduction of a new NGSO system alone would be unacceptable. The introduction of a NGSO FSS system should not preclude a future GSO FSS earth station from being established with the same coordination regime.

23. GSO satellites operating in inclined orbit should be afforded protection. Telesat has in the past operated satellites in inclined orbit with inclinations of up to five degrees. As an example, a technical analysis for a satellite network currently in operation shows the technical feasibility of operation up to 5.5 degrees. Even this limit could be increased with additional data buffering at the earth stations. The hard limit is achieved when the satellite excursions result in negative elevation angles for part of the diurnal cycle, which is a function of earth station latitude and longitude difference between the inclined satellite and the earth station. Typically, the hard limit is achieved at inclinations well above five degrees. Telesat therefore suggests that protection be afforded for inclinations of at least five degrees, and preferably to six degrees.

24. At paragraph 29 of the NPRM, regarding protection of telemetry, tracking and command links, Telesat agrees with the proposal that interference avoidance during the launch and transfer orbit phases be accomplished by consultations between GSO and NGSO operators. Consultations between operators of GSO FSS spacecraft have worked well in the past and Telesat would anticipate that direct consultations between the operators of GSO and NGSO

spacecraft would be done in a similar manner to avoid interference during the launch and transfer orbit phases of either system. No relaxation in the requirement to have operator-to-operator consultations should be considered for NGSO operators regardless of the complexity or burden which may result from ensuring that GSO systems will not be harmfully impacted by frequent launches of new NGSO spacecraft.

25. Regarding the proposals in paragraphs 47 through 50 of the NPRM concerning sharing between NGSO FSS uplinks and BSS reverse band downlinks in the 17.3 – 17.8 GHz band, Telesat concurs that sharing between either NGSO user terminals or uplinks and BSS reverse band downlinks in this range would be impractical given that ubiquitous deployment of BSS terminals is expected and that large coordination distances (i.e., minimum distance of 9.4 kilometers with shielding) between the two services would be necessary, should sharing be implemented.

26. Telesat also concurs with the Commission's proposals set out in paragraphs 78 and 79 of the NPRM concerning NGSO User Terminal Earth Station Reference Patterns and NGSO Gateway Earth Station Reference Patterns, requiring that NGSO FSS user terminal antennas meet the antenna performance requirements of Section 25.209 of its rules.

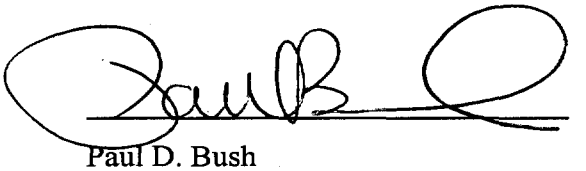
27. Regarding the request for comment in paragraph 83 of the NPRM on RF bio-hazard safety rules, Telesat would propose that all transmitting NGSO terminals be installed in an area where access is limited by fencing or similar means. In addition to meeting applicable safe radiation hazard levels as specified in Part 25 of the Commission's rules, all such terminals should have appropriate environmental clearances, municipal approvals and radiation hazard labeling that are also applicable to GSO FSS terminals. Furthermore, in consideration of the need for the NGSO terminals to point in virtually a 360° range in azimuth, Telesat would recommend that all such terminals be mounted such that the minimum height of any antenna forming part of the terminal be at least two meters above the surface on which it is installed. Also, in order to limit the potential for human exposure, if the antenna is ground mounted, the minimum height should be two meters above the highest point on the ground or man-made structure within 30 meters in any direction of the antenna.

28. Regarding the Petition for Rulemaking filed by Northpoint as described in paragraph 91 of the NPRM, Telesat would emphasize the ubiquitous nature in which DBS receivers have been deployed and are continuing to be deployed throughout their service areas. Any technical sharing studies should consider the potential for strong reflections off buildings or other man-made objects which may be located on azimuths between receiving DBS terminals and the BSS spacecraft from which the terminals are receiving signals. Also, recent studies within the JTG have shown that 45 cm terminals currently being deployed in the BSS band in Region 2 have a significant side lobe roughly perpendicular to the terminal's bore sight. (Ref. ITU-R JTG 4-9-11 doc. 356) This high side lobe would point toward an azimuth equal to that of the BSS spacecraft minus 180° with an elevation angle equal to that of 90° minus the elevation angle toward the BSS spacecraft. That is, the side lobe would be roughly aligned with the proposed Northpoint transmitter.

CONCLUSION

29. Telesat appreciates the opportunity to provide its comments to the Commission, and trusts that these comments will be of assistance to the Commission in its deliberations on these very important matters.

All of which is respectfully submitted this 2nd day of March 1999.



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Annex A

The following is extracted, with some minor modifications to certain of the numbers, from the Canadian contribution document 361 to JTG 4-9-11:

1. Description of GSO/FSS Input Parameters and Assumptions

The GSO/FSS parameters given in Table 1 represent the worst case for a given size of receive earth station antenna located in a given ITU-R rain zone. The common characteristic of each link is that it has been designed to achieve the desired link availability without additional link margin. Other receive earth station terminals in the same rain zone but located in regions of higher downlink EIRP will actually achieve higher link availability. Notwithstanding the fact that the GSO/FSS link parameters given in Table 2 are defined as being worst case links, the list is not exhaustive. There may be GSO/FSS link parameters for other types of services whose combination of geographic locations, receive earth station antenna size and rain zone make those other links even more sensitive than those which have been examined.

2. GSO/FSS Link Performance Objectives

All of Telesat links have only one defined point of performance and that is referred to as the "Threshold C/(N+I)" in Table 1. The "Critical C/(N+I)" was selected because it allows one to calculate what the short-term impact of the non-GSO interference will be. The difference between the percentage of time that this "Critical C/(N+I)" is exceeded with non-GSO and without non-GSO interference gives an indication of the increased percentage of time over and above that which is caused solely due to rain fade that the link may experience severe outages when the "application gets dropped". The actual level below the "Threshold C/(N+I)" that the critical C/(N+I) is approached, is network dependent and thus values had to be chosen that were representative of where the onset of severe outages of typical systems would occur. For systems such as a DTH service using DVB which employs Forward Error Correction with block coding, such as 188/204 Reed-Solomon, the "Critical C/(N+I)" was taken to be 1.0 dB below the "Threshold C/(N+I)". For systems employing only Forward Error Correction with no block the "Critical C/(N+I)" was taken to be 1.5 dB below the "Threshold C/(N+I)".

The present analysis only calculates the statistical percentage increase in time that the GSO/FSS link will be degraded to its "Critical C/(N+I)", where the number of events and duration of such event s will determine the overall impact of such degradations.

3. Assumptions Common to all GSO/FSS Links

The total C/I was calculated on both the uplink and the downlink and knowing the uplink and the downlink $C/I_{\text{Adj Sat}}$, both uplink and downlink C/I_{Other} could be calculated. Given that link budget calculations need to handle the uplink and downlink adjacent satellite interference components separately from the other interference components, a separate C/I term C/I_{Other} was calculated to represent all other interferences on both the uplink and the downlink as applicable. It was deemed unnecessary to provide any pointing errors for the transmit or the receive earth station antennas or for the uplink/downlink satellite antennas. Since only epfd's for non-GSO downlinks were being tested, it was not necessary to provide the peak receive gain of the satellite

uplink. The following parameters have all been adjusted to their respective minimum values to reflect that all antenna-pointing errors are listed as zero:

- transmit earth station EIRP
- satellite receive gain
- satellite downlink EIRP
- receive earth station gain

The link budget calculations used to calculate the link availability for the links in Table 2, used the above four link parameters at their minimum values equal to the nominal values less the applicable pointing errors. The same four parameters in Table 1 are nominal values less pointing errors.

The GSO/FSS links parameters are representative of type of services which currently represent a large portion of Telesat Canada's business. Major applications of the 14/12 GHz frequency band using GSO/FSS satellites in Canada include Direct-to-Home (DTH), delivery of wide-band digitally compressed video channels to cable-head-ends and data networks using Very Small Aperture Terminals (VSAT's). Other links, which must be protected but have not been addressed here include point-to-point data, analog FM/TV, telemetry and partial channel SCPC digitally video compression.

4. Types of Links Examined

4.1 DTH Service (Anik E2)

Direct-to-Home (DTH) service providers, using Ku-band space segment on Anik E2 currently provide service to a large number of DTH subscribers across Canada using receive earth station terminals ranging in size from 60 cm to 120 cm in diameter. These terminals are not licensed, are ubiquitously deployed and thus the exact location of the terminals are not known. The current interference environment due to adjacent GSO/FSS satellites is known and both the uplink and the downlink carrier to adjacent satellite interference ratios have been calculated at each of the links specific to the geographic location of the receive earth station terminal. The uplink location for both DTH service providers is in the vicinity of Toronto, Ontario, Canada. Common to all DTH links in Table 1 is the uplink EIRP, a total power input back-off of 3 dB and the assumption that both of the two DTH carriers in each 54 MHz transponder are transmitted from the same earth station location, which is the common mode of operation. An uplink power control (UPC) of 6 dB was used in each DTH link. It was assumed that the UPC compensated perfectly for uplink fades, which is not possible, however, given that the nominal level of input back-off for each carrier (IBOi) is at 6 dB, the error was considered to be small given the compression at the output with this operational point.

Canada has two major DTH service providers. Although Telesat Canada, in the second quarter of 1999, plans to launch CANBSS2, a 32 channel BSS satellite which will be utilizing the AP30/30A bands, one of the major DTH service providers will continue to provide service to their subscribers until the launch of Anik E2's replacement in the year 2000. Following the launch of Anik E2's replacement, one DTH service provider has contracted to continue providing DTH service to its subscribers in the 14.0-14.5 /11.7-12.2 GHz band for the nominal 15 year life-span of the Anik E2R.

4.2 Cable Head-End Reception (Anik E2)

Cable head-end reception of the same DTH carriers received by DTH subscribers is another major application on the Anik E2 satellite. Although the demodulation equipment at the cable head-end is essentially the same as that used by a DTH subscriber terminal, a C/(N+I) operational threshold of 1 dB greater has been used. This additional 1 dB is required to compensate for signal distortions which are introduced in the network of cables, filters and amplifiers commonly found in cable sites. The required quality of service, however, is much greater for a cable operator since the signal must be demodulated and reprocessed for distribution to thousands of customers in their cable networks. A typical quality of service to a cable-head end has roughly 1/10 the unavailability of a consumer grade DTH service. In analyzing the impact of the provisional epfd limits on the delivery of DTH carriers to cable head-ends, an availability of 99.97% has been used.

4.3 VSAT Networks (Anik E1)

Very Small Aperture Terminals (VSAT's) in a mesh type of configuration having a common outroute from a hub which is received by many remote terminals Canada-wide, ranging from 1.0 to 1.8 m in diameter is another common application in Canada in the 14/12 GHz band. The outroutes have a high availability on the uplink due to 10 dB of uplink power control. The actual availability achieved on the outroute will be better than that which has been calculated since a minimum availability of 99.9% is quoted Canada-wide. None of the VSAT inroutes or outroutes were found to be impacted by more than the 10% increase in unavailability criterion and thus the results have not been shown here.

4.4 Anik C1 Inclined Orbit

Anik C1 will be used to provide heavy-route digital service between 7.6-m earth stations in South America. The service will be provided up to a maximum inclination of +/- 5.5 °.

5. Computer Simulations

Given the technical parameters for the Canadian GSO FSS links listed in Table 1, the time availability of each link is calculated in the presence of rain fading only and also in the presence of both rain fading and interference from one non-GSO system. The epfd and apfd limits are considered acceptable when all GSO carriers meet the 10% non-GSO degradation requirement. Since the links shown in Table 1 do not meet the 10% degradation requirement with the current epfd limits of WRC-97, new epfd limits are needed.

6. Summary of Results

The provisional limits of epfd as set at WRC-97 will cause the "10% criterion" to be exceeded on some of the links examined. Table 2 shows the calculated increase in unavailability for the 5 selected links in Table 1. The 10% criterion is exceeded for carriers 1, 5, 8, 9 and 22.

7. Conclusions

Based on the assumptions used and given the results in Table 2, it can be seen that the selected GSO/FSS links, when subject to the combined effect of rain fading and non-GSO/FSS interference as represented by the provisional epfd's of WRC 97 will experience increases in unavailability in excess of the "10% criterion". For antennas smaller than about 3 m, the long-term performance objective is impacted the most whereas for larger antennas, the shorter-term performance objectives are impacted more.

The links affected most, whether the criterion was exceeded or not, were those with receive terminals in drier climates.

This analysis has only considered the impact of non-GSO/FSS systems into selected GSO FSS links based on the provisional downlink interference limits (provisional epfd's at Ku-band adopted at WRC-97). The impact of non-GSO/FSS systems similarly into the uplink (provisional apfd's at Ku-band adopted at WRC-97) has not been considered here. The addition of uplink interference in the form of uplink apfd limits will only add to the increase in availability calculated. In order to remain consistent with the 10% criteria, the epfd limits would have to be modified in order to avoid a significant impact from non-GSO downlinks into GSO receivers.

TABLE 1: CANADIAN GSO/FSS SYSTEM PARAMETERS

GEOSTATIONARY NETWORK						
Name of GSO Satellite		**Anik E2**	**Anik E2**	**Anik E2**	**Anik E2**	**Anik C1**
Performance Objectives (before InGSO is introduced)		**1**	**6**	**8**	**9**	**22**
Threshold C/(N+I) (Margin = 0)	(dB)	3.85	6.61	7.61	7.61	7.52
% Exceeded	(%)	99.50	99.70	99.97	99.97	99.50
Critical C/(N+I) (Margin -1.0 or -1.5 dB)	(dB)	2.85	5.61	6.61	6.61	6.52
% Exceeded	(%)	99.842	99.874	99.976	99.975	99.540
Waveform Description						
Access type (TDMA, CDMA, FDMA,...)		FDMA	FDMA	FDMA	FDMA	FDMA
Modulation type (e.g. FM, QPSK, BPSK)		QPSK	QPSK	QPSK	QPSK	8PSK
Noise Bandwidth per carrier	(kHz)	24000	24000	24000	24000	23975
Transmit Earth Station Characteristics						
Altitude (amsl)	(km)	0.0	0.0	0.0	0.0	0.0
Latitude from Equator (+N/-S)	(°)	43.7	43.7	43.7	43.7	-23.0
Elevation angle	(°)	32.4	32.4	32.4	32.4	16.8
Temperature at ground level	(°C)	15	15	15	15	5
Relative humidity	(%)	50	50	50	50	50
Rain model (ITU/Crane)		ITU-R1	ITU-R[1]	ITU-R[1]	ITU-R1	ITU-R1
Rain zone (as per rain model)		K	K	K	K	N
Rainfall rate exceeded for 0.01% (avg. year)	(mm/h)	42	42	42	42	95
On-axis Earth Station transmit EIRP	(dBW)	73.50	73.50	73.50	73.50	77.72
Antenna pointing loss towards wanted GSO satellite	(dB)	0.0	0.0	0.0	0.0	0.0
Uplink Power Control (UPC) range (>0, 0 dB if none)	(dB)	6.01	6.01	6.01	6.01	0.0
Power control accuracy (applicable only if UPC used)	(dB)	0.01	0.01	0.01	0.01	0.00
RECEIVE EARTH STATION CHARACTERISTICS						
Altitude (amsl)	(km)	0.00	0.00	0.00	0.00	0.00
Latitude from Equator (+N/-S)	(°)	49.0	49.5	63.8	62.6	-22.0
Temperature at ground level	(°C)	15	15	15	15	
Relative humidity	(%)	50	50	50	50	
Elevation angle	(°)	33.5	32.9	11.4	19.0	20.4
Rain zone (as per rain model)		E	E	A	C	N
Rainfall rate exceeded for 0.01% (avg. year)	(mm/h)	22	22	8	15	95
Earth station RX noise temperature	(K)	146.5	146.5	141.5	141.5	140.0
On-axis antenna gain	(dBi)	35.59	41.49	51.07	49.25	57.49
Antenna diameter	(m)	0.6	1.2	3.7	3.0	7.6
Antenna pointing loss	(dB)	0.0	0.0	0.0	0.0	0.0
SPACE STATION RECEIVE CHARACTERISTICS						
Transponder bandwidth	(MHz)	54	54	54	54	54
Receive frequency	(GHz)	14.25	14.25	14.25	14.25	14.25
Receive polarization (H: horizontal, V: Vertical, C: Circular)		H	V	V	H	H
Automatic Level Control (ALC) range (0 dB if none)	(dB)	0.0	0.0	0.0	0.0	0.0
Peak receive antenna gain	(dBi)	32.43	32.43	32.43	32.43	28.97
Receive satellite antenna gain in the direction of transmit earth station	(dBi)	32.43	32.43	32.43	32.43	28.97
Satellite receive temperature	(K)	650	650	650	650	1250
Transponder total input back-off (IBO)	(dB)	3.00	3.00	3.00	3.00	3.00
SPACE STATION TRANSMIT CHARACTERISTICS						
Transmit frequency	(GHz)	11.95	11.95	11.95	11.95	11.95
Transmit polarization (H: horizontal, V: Vertical, C: Circular)		V	H	H	V	V
Transponder total output back-off (OBO)	(dB)	1.61	1.61	1.61	1.61	1.61
Satellite EIRP in the direction of the receive earth station	(dBW)	42.80	40.25	34.23	36.48	37.38
Transparent/remodulating transponder		T	T	T	T	T
INTERFERENCE FROM OTHER GSO NETWORKS AND TERRESTRIAL SERVICES						
Uplink clear-sky C/I due to other GSO networks	(dB)	31.85	32.55	32.55	31.85	19.55
Downlink clear-sky C/I due to other GSO networks	(dB)	19.47	30.59	59.13	48.66	71.57
ADDITIONAL CHARACTERISTICS IN THE ABSENCE OF non-GSO INTERFERENCE						
Transmission Gain	(dB)	-25.97	-22.64	-19.72	-19.00	-10.15
System Margin	(dB)	1.57	2.12	3.63	4.49	6.07
Uplink C/I_{Other}[2]	(dB)	25.42	25.42	25.42	25.42	21.54
Uplink total C/I	(dB)	24.53	24.65	24.65	24.53	17.42
Downlink C/I_{Other}[2]	(dB)	24.71	24.84	21.07	24.66	18.47
Downlink total C/I	(dB)	18.33	23.82	21.07	24.65	18.47
Total Clear-Sky C/(N+I)	(dB)	5.42	8.73	11.25	12.11	13.59

NOTES

1) The ITU-R Rain Attenuation Model is that of Rec. P.618-5.

2) Carrier-to-Interference (other than Adjacent GSO Satellite)

Table 2: Availability of FSS Links due to Rain and NGSO Interference Using Method D

Epfd levels used in the study based on Article S22.2 provisional limits (dBW/ m² /4kHz)	Carrier Description	Performance Criteria		Percentage of unavailability due to rain with and without NGSO interference			
		Threshold C/(N+I) (dB)	% of time C/(N+I) ≤ Threshold C/(N+I)	C/(N+I)	% of time C/(N+I) ≤ C/(N+I) value	% of time C/(N+I) ≤ C/(N+I) criteria with interference using Article S22.2 epfd limits (%)	Percentage of unavailability increasing due to interference (%)
Epfd level for a **60cm** Antenna ES WRC-97 epfd Limits	Carrier 1 DTH 60cm Zone E	3.85	0.5	3.85 2.85	0.496 0.164	0.568 0.176	14.6 7.8
Epfd level for a **1.2m** Antenna ES ≤ -187.9 for 0% ≤ -187.9 for 99.7% ≤ -170.3 for 99.7% ≤ -170.3 for 100%	Carrier 5 DTH 1.2m Zone E	6.61	0.3	6.61 5.61	0.359 0.143	0.674 0.153	87.6 7.7
Epfd level for a **3.7m** Antenna ES Same as for a 3.0 m antenna	Carrier 8 Cable Head-end 3.7m Zone A	7.61	0.03	7.6 6.6	0.028 0.012	0.058 0.046	104 128
Epfd level for a **3.0m** Antenna ES ≤ -192.0 for 0% ≤ -192.0 for 99.9% ≤ -186.0 for 99.9% ≤ -186.0 for 99.97% ≤ -173.0 for 99.97% ≤ -173.0 for 99.999% ≤ -170.0 for 99.999% ≤ -170.0 for 100.0%	Carrier 9 DTH 3m Zone C	7.61	0.03	7.61 6.61	0.027 0.017	0.056 0.019	104 9.4
Epfd level for a **7.6m** Antenna ES (uses the 10m limit) ≤ -195.0 for 0% ≤ -195.0 for 99.97% ≤ -178.0 for 99.97% ≤ -178.0 for 99.999% ≤ -170.0 for 99.999% ≤ -170.0 for 100.0%	Carrier 22 7.6m Zone N	7.52	0.5	7.55 6.5	0.385 0.296	77.18 34.89	19945 11692